

Appl. No. 10/708,648
Amdt. Dated 05/03/2006
Reply to Office action of March 3, 2006

REMARKS/ARGUMENTS

This is in response to Final Office action dated 03/03/06 and having a period of response set to expire on 06/03/06.

Status

Claims 1-18 are pending

Claims 1-18 are rejected

Rejection(s) under 35 USC 103

Claims 1-5, 7-11 and 14-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim et al. (US Pat. 2004/0214446) in view of Stojakovic et al (US Pat. 2005/0051820) for the reason of record.

As noted by the Examiner, claim 1 generally requires a method of forming an oxidized tantalum nitride hard mask for dual damascene processing, the method comprising providing a semiconductor wafer, the wafer comprising: a base dielectric layer, a cap layer overlying the base dielectric layer, a dielectric layer overlying the cap layer, one or more hard mask layer overlying the dielectric layer and a tantalum nitride layer overlying the hard mask layers, subjecting the tantalum nitride layer to an oxidation process to convert tantalum nitride layer to oxidized tantalum nitride (TaOxNx).

Further, as noted by the Examiner, Figure 1 of Kim et al. discloses a semiconductor wafer comprising a dielectric layer 105, a cap layer 110, overlying the base dielectric a dielectric layer 112, overlying the cap layer a hard mask layer 114, overlying the dielectric layer and forming trench 116 (See page. 5, paragraph [0060-621]), a tantalum nitride layer 324 overlying the hard mask layer (See page. 8, paragraph [0086]).

In sum, Kim et al discloses all of the claimed features as stated above except for forming a tantalum nitride layer overlying the hard mask layers and subjecting the tantalum nitride layer to an oxidation process to convert tantalum nitride layer to oxidized tantalum nitride (TaOxNx).

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Forming a tantalum nitride layer (top hardmask layer) overlying the hard mask layers and subjecting the 'top hardmask' tantalum nitride layer to an oxidation process to convert tantalum nitride layer to oxidized tantalum nitride (TaOxNx) is at the core of the present invention as discussed in more detail below.

Kim et al was modified by the teachings of Stojakovic et al. The Stojakovic et al. discloses exposing a multiple hard mask layer such as a tantalum nitride layer to an oxidation process to convert the tantalum nitride layer to oxidized tantalum nitride layer (See page 1, paragraph [0007]). However, there is no mention of the thickness of the tantalum nitride layer or the thickness of the oxidized tantalum nitride layer.

By contrast, as discussed in paragraph 34 of the present patent application as originally filed, the tantalum nitride hard mask layer has a thickness of 5-25nm (see paragraph 32 of the present application). When the tantalum nitride hard mask layer is subjected to a thermal and plasma oxidation process, the tantalum nitride hard mask layer is converted to an oxidized tantalum nitride hard mask layer that is thicker than the tantalum nitride hard mask layer by a factor of 2 to 4 times and an increased transparency by a factor of ten times. As discussed in paragraph 20 of the present application, the increased thickness provides better critical dimension control against the etching processes used to etch hybrid or inorganic dielectrics. The increased transparency permits accurate optical alignment of lithographic processes to underlying alignment features.

Claim 1 has been amended to incorporate the limitations of:

- 1) the tantalum nitride top hardmask layer having a thickness of 5-25nm" overlying the one or more hardmask layers; and
- 2) converting the tantalum nitride top hardmask layer to an oxidized tantalum nitride (TaOxNx) top hardmask layer having a thickness of 2-4 times thicker and an increased transparency by a factor of more than 10 times than that of the tantalum nitride top hardmask layer.

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Neither Kim Stojakovic et al. teach or suggest converting a tantalum nitride top hardmask layer to an oxidized tantalum nitride top hardmask layer having a thickness of 2-4 times thicker than the tantalum nitride top hardmask layer as now claimed. In addition, neither of the references teach or suggest converting a tantalum nitride top hardmask layer to an oxidized tantalum nitride top hardmask layer having an increased transparency by a factor of more than 10 times than that of the tantalum nitride top hardmask layer.

Accordingly, independent claim 1 as amended should be deemed allowable.

Claims 2-8 depend upon base claim 1 and should also be deemed allowable.

Independent Claim 9 has been amended to include the limitations of:

1) forming a tantalum nitride top hardmask layer having a thickness of 5-25nm over the second hardmask layer; and

2) subjecting the etched tantalum nitride top hardmask layer to an oxidation process to convert the tantalum nitride top hardmask layer to an oxidized tantalum nitride top hardmask layer having a thickness of 2-4 times thicker than the tantalum nitride top hardmask layer.

For the same reasoning as set forth with regard to claim 1, these limitations are not taught or suggested by the prior art taken alone or in combination and therefore claim 9 should be deemed allowable.

Claims 10-13 depend upon base claim 9 and should also be deemed allowable.

Independent Claim 14 has been amended to include the limitations of:

1) forming a tantalum nitride top hardmask layer having a thickness of 5-25nm over the second hardmask layer; and

subjecting the tantalum nitride layer to an oxidation process to form an oxidized tantalum nitride top hardmask layer having a thickness of 2-4 times thicker than the tantalum nitride top hardmask layer.

For the same reasoning as set forth with regard to claim 1, these limitations are not taught or suggested by the prior art taken alone or in combination and therefore claim 14 should be

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deemed allowable.

Claims 15-18 depend upon base claim 14 and should also be deemed allowable.

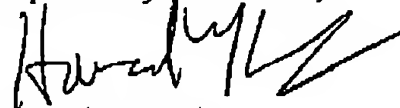
Claims 6, 12, 13, 17 and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim et al. (US Pat. 2004/0214446) in view of Stojakovic et al. (US Pat. 2005/0051820) further in view of Narwankar et al. (US Pat. 2003/0025146) for the reason of record.

Narwankar et al. does not teach or suggest converting a tantalum nitride top hardmask layer to an oxidized tantalum nitride top hardmask layer having a thickness of 2-4 times thicker the tantalum nitride top hardmask layer as now claimed. In addition, Narwankar et al. does not teach or suggest converting a tantalum nitride top hardmask layer to an oxidized tantalum nitride top hardmask layer having an increased transparency by a factor of more than 10 times than that of the tantalum nitride top hardmask layer. Accordingly, Kim et al. in view of Stojakovic et al. in combination with Narwankar et al. does not teach or suggest the limitations of claims 1, 9 or 14 as amended.

Conclusion

Applicant respectfully requests that a timely Notice of Allowance be issued in this case.

Respectfully submitted,



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